Transactions - Geothermal Resources Council 2010 vol.34 2, pages 1075-1080

Characterizing non-fickian transport in fractured rock masses using fractional derivative-based mathematical model

Suzuki A., Chiba R., Okaze T., Niibori Y., Fomin S., Chugnov V., Hashida T.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

A fractional advection-dispersion equation (fADE) was employed to describe non-Fickian mass transport in fractured rock masses. A fracture network model based on fractal geometry was utilized to analyze numerical tracer responses in inhomogeneous rock masses composed of a number of natural fractures. The density of the natural fractures was varied in the numerical analyses. It was shown that non-Fickian transport (anomalous dispersion with heavy tails) was observed for lower natural fracture densities and the tracer response could be described by the fADE. It was suggested that the term of fractional time derivative in the fADE was responsible for the variance of travel time in the tracer responses, resulting in the non-Fickian transport. The results obtained in this study may support the use of the fADE for characterizing complex fluid flow in geothermal reservoirs.

Keywords

Fractal geometry, Fractional derivative, Fracture network, Mass transport, Non-fickian diffusion, Tracer test